Load Flow Analysis on IEEE 14 Bus System Using N-R Method

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Abstract
The analysis and design of energy systems is usually carried out using a power flow analysis. This analysis is carried out at the stage of planning, operation, control and economic programming. They are useful for determining the magnitude and phase angle of the load buses and the real and reactive power flows on the transmission lines, as well as the real and reactive powers injected into the buses. A modified fast decoupling method is introduced to improve performance over traditional power flow analysis methods. For a modified version of the fast-decoupling method, both the change in stress magnitude and the stress angle are computed and applied in the same iteration to minimize the total computation time. The load flow analysis includes stationary power flow and voltage analyses as well as considerations for optimal power flow calculation. This best practice emphasizes the use of computer-aided analysis software with a list of recommended desirable features to conduct a modern load flow study. Also, examples of system data requirements are presented and techniques for analyzing results are presented. B. Methods for charge flow analysis, DC charge flow, Gauss-Siedel method, Newton-Raphson method and Fast Decoupled method. The aim of this article is to present the simulation result in MATLAB software for calculating voltage magnitude and phase angle, active power and reactive power on the bus for IEEE 14 bus systems.

Keywords: 14 bus system, power flow, optimization

I. Introduction

Load glide research are used to make sure that electrical electricity switch from mills to clients thru the grid machine is stable, dependable and monetary. Conventional strategies for fixing the weight glide hassle are iterative the usage of the Gauss- Seidel techniques Load glide evaluation paperwork an vital prerequisite for electricity machine research. Considerable studies have already been performed withinside the improvement of pc packages for load glide evaluation of massive electricity structures. However, those general-cause packages may also stumble upon convergence problems whilst a radial distribution machine with a massive range of buses is to be solved and, hence, improvement of a unique application for radial distribution research will become necessary.

There are many answer strategies for load glide evaluation. The answer approaches and formulations may be particular or approximate, with values adjusted or unadjusted, meant for both online and off-line application, and designed for both single-case or multiple-case applications. Since an engineer is constantly worried with the fee of merchandise and services, the green ultimate monetary operation and making plans of electrical electricity era machine have constantly occupied an essential function withinside the electric powered electricity industry. With massive interconnection of the electrical networks, the electricity disaster withinside the international and non-stop upward thrust in prices, it's miles very vital to lessen the strolling costs of the electrical electricity. A saving withinside the operation of the machine of a small percentage represents a vast discount in running fee in addition to withinside the portions of gas consumed. The conventional hassle is the monetary load dispatch of producing structures to obtain minimal running fee.

Steady nation operation subjected to sure inequality constraints beneath Neath which the machine operates. Load glide research is essential in making plans and designing destiny growth of electricity structures. The have a look at offers constant nation answers of the voltages at all of the buses, for a specific load condition. Different constant nation answers may be obtained, for specific running conditions, to assist in making plans, layout and operation of the electricity machine Generally, load glide research are constrained to the transmission machine, which entails bulk electricity transmission. The load on the buses is thought to be regarded. Load glide research throw mild on a few on the buses, overloading of lines, overloading of mills, balance margin discount, indicated through electricity attitude variations among buses connected through a line, impact of contingencies like line voltages, emergency shutdown of mills, etc. Load glide research is required for finding out the monetary operation of the electricity machine. They also are required in brief balance research. Hence, load glide research plays a crucial position in electricity machine research. Thus, the weight glide hassle includes locating the electricity flows (actual and reactive) and voltages of a community for given bus conditions. At every bus, there are 4 portions of hobby to be regarded for in addition evaluation: the actual and reactive electricity, the voltage significance and its section attitude. Because of the nonlinearity of the algebraic equations, describing the given electricity machine, their answers are obviously, primarily based totally at the iterative techniques only.

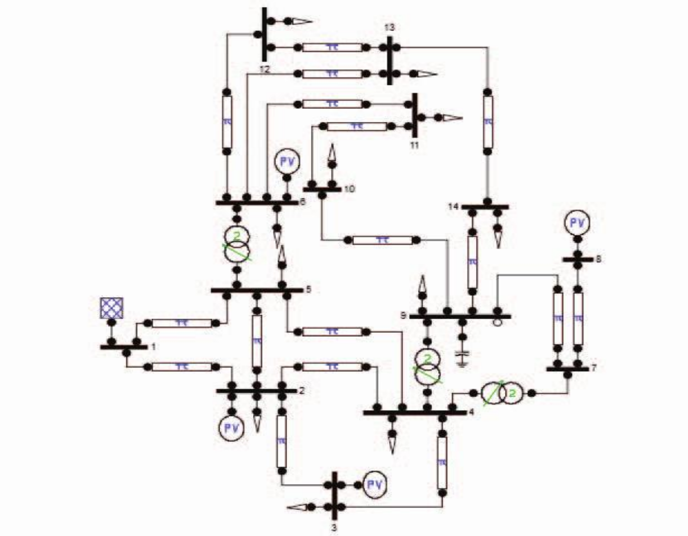

Fig. 1: Load Flow Analysis on IEEE 14 Bus System Using N-R Method

II. Classification of Buses

In an electrical electricity system, all of the buses represent of 4 variables, which might be voltage value, voltage segment perspective, lively electricity and reactive electricity in line waft. For electricity waft answer out of those 4 variables, are made consistent and are handled as variable. All the buses are categorized on the idea of the consistent parameters.

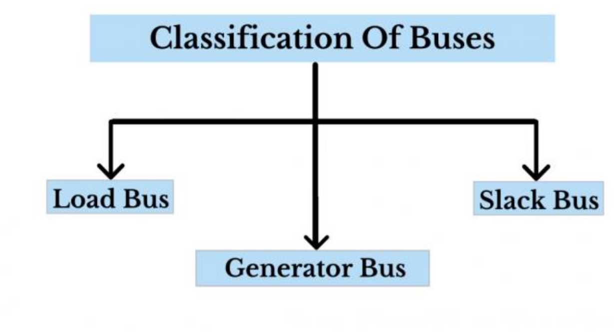

Fig 2: Classification of Buses

1. Load buses- This is also called the P-Q bus and at this bus, the active and reactive power is injected into the network. The magnitude and phase angle of the voltage is to be computed. Here the active power P and reactive power Q are specified, and the load bus voltage can be permitted within a tolerable value, i.e., 5 %

2. Generator Bus or Voltage Controlled Bus - This bus is also called the P-V bus, and on this bus, the voltage magnitude corresponding to generate voltage and true or active power P corresponding to its rating are specified. Voltage magnitude is maintained constant at a specified value by injection of reactive power. The reactive power generation Q and phase angle δ of the voltage is to be computed.

3. Slack bus or Reference Bus-Slack bus in a power system absorbs or emits the active or reactive power from the power system. The slack bus does not carry any load. At this bus, the magnitude and phase angle of the voltage is specified. The phase angle of the voltage is usually set equal to zero. The active and reactive power of this bus is usually determined through the solution of equations.

The slack bus is a fictional concept in load flow studies and arises because the I^2R losses of the system are not known accurately in advance for the load flow calculation. Therefore, the total injected power cannot be specified on every bus. The phase angle of the voltage at the slack bus is usually taken as reference or zero.

III. Newton Raphson Method

Newton Raphson technique is the exceptional opted technique for fixing non-linear load waft equations because it offers higher convergence pace as evaluate to different load waft methods. The quantity of iterations concerned in Newton Raphson technique is impartial of quantity of buses taken into consideration, subsequently electricity waft equations may be solved simply in few iterations. Newton Raphson technique transforms the set of non-linear equations into a hard and fast of linear equations which technique to the authentic answer efficiently. The Newton Raphson technique is the maximum strong electricity waft set of rules utilized in practice. However, disadvantage of this technique lies withinside the reality that the phrases of the Jacobian matrix should be recalculated after which the complete set of linear equations should additionally be solved in every iteration.

IV. Computational Algorithm For Newton Raphson Load Flow Method

To perform load flow analysis using the Newton Raphson method, the algorithm developed is as follows:

Step 1: Form the nodal admittance matrix ( ).

Step 2: Assume an initial set of bus voltage and set bus n as the reference bus as :

(at all PV Buses).
(at all PQ Buses).

Step 3: Calculate the real Power using the load flow equation;

$$P_i = G_{ii}|V_i|^2 + \sum_{j=1}^{n} |V_i||V_j|\left(G_{ij}\cos\theta_{ij} + B_{ij}\sin\theta_{ij}\right)$$

Step 4: Calculate the reactive Power Qi using the load flow equation;

$$Q_i = -B_{ii}|V_i|^2 + \sum_{j=1}^{n}|V_i||V_j|\left(G_{ij}\sin\theta_{ij} - B_{ij}\cos\theta_{ij}\right)$$

Step 5: Form the Jacobian matrix using sub-matrices H, N K and L.

Step 6: Find the power differences and for all
i ;
$\Delta Pical.$

Step 7: choose the tolerance values.
Step 8: Stop the Iteration if all and are within the tolerance values.

Step 9: Update the values of and using the equation,
$x^{k+1} = x^k + \Delta x^k$

Detailed flow chart for Newton-Raphson load flow method:

In context to various steps involved in carrying out load flow studies with Newton Raphson method, following detailed flow chart has been designed:

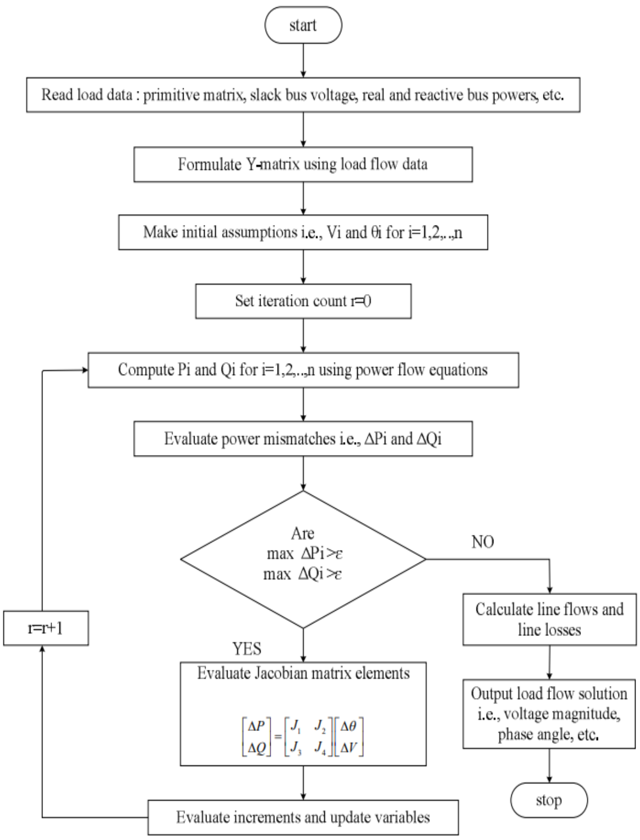

Fig 3. Detailed flowchart of Newton Raphson method

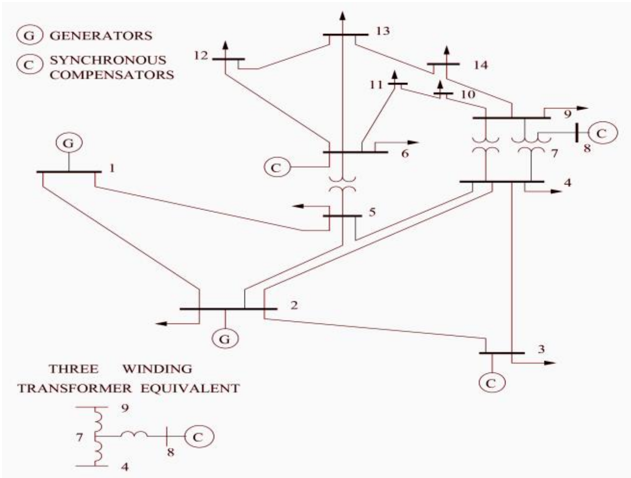

Fig. 4 IEEE 14 Bus System

Properties of Load Flow Solution Method

To be a good method for load flow analysis, it must acquire the following properties:

a. **High computational speed**. To deal with large power system networks, real-time applications or multiple case data, high computational speed is required for efficient results.
b. **Low computer storage**. Large computer memory is required to store load flow data for large power system networks and this can be achieved by using mini-computers mainly for online applications.
c. **Reliability of solution.** It is very essential that the results obtained after carrying out load flow calculations must be reliable and should provide efficient data.
d. **Versatility**. The versatility of the solution means the ability of the load flow method to handle conventional and special features. E.g. the adjustment of tap ratios on transformers. The load flow solution obtained must be a versatile one.
e. **Simplicity**. While carrying out load flow calculations, the load flow method should provide ease of coding a computer program for the load flow algorithm so that calculations can be done conveniently.

V. Conclusion

In this paper, The IEEE 14 bus machine is analysed with the aid of using the use of Guass-Seidel approach. This is tested with the aid of using calculating hand calculations with the aid of using the use of the Guass-Seidel equations and MATLAB application for five bus pattern machines. Both those outcomes are determined equal .so this form of MATLAB programming may be very beneficial for fixing load glide problems. Fast Decoupled approach offers the about identical end result as acquired with the aid of using NR approach with least no of generation. Fast decoupled approach converges very dependable and rapid in 2-five iterations, a great approximate answer is acquired after first or 2d generation This MATLAB application may be relevant for any variety of buses. The well-known IEEE 14 bus enter facts is used for IEEE 14 bus machine and pattern five bus enter facts is used for five bus machines. The destiny scope for this undertaking may be prolonged with Newton-Raphson approach and Fast Decoupled methods.

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